5/2/11 Baker Risk
Don Ketchum

13c)

1 OBSERVATIONS

The following are key observations from the incident.

1. At every point in time, the recorded pressures in the SCC were greater than elsewhere in the system.

Table 1. Recorded Pressures at Incinerator Locations

Time	Kiln PT4305	SCC PI 4300A&B	Boiler PI 5005	ESP PI 6604
22:40:05	1	0.15	-1	-3
22:40:06	1	3.2	2/1.4	-2
22:40:07	-1.2	4.8	3.0	-1.2
22:40:08	-3.1	4.8	3.0	0.6
22:40:09	-3.8	5.0	3.1	0.9
22:40:10	-3.2	4.1	1.6/1.4	1.0
22:40:11	-1.5	2.8	0.85	0
22:40:12	-0.7	1.5	0.25	-1.2

Note: the event is first noticed at 22:40:06

2. The pressure in the SCC build over the course of about three seconds then returns to ambient as shown in Figure 1. This is very similar to the pressure history recorded on December 22, 2010 (see Figure 2).

3.

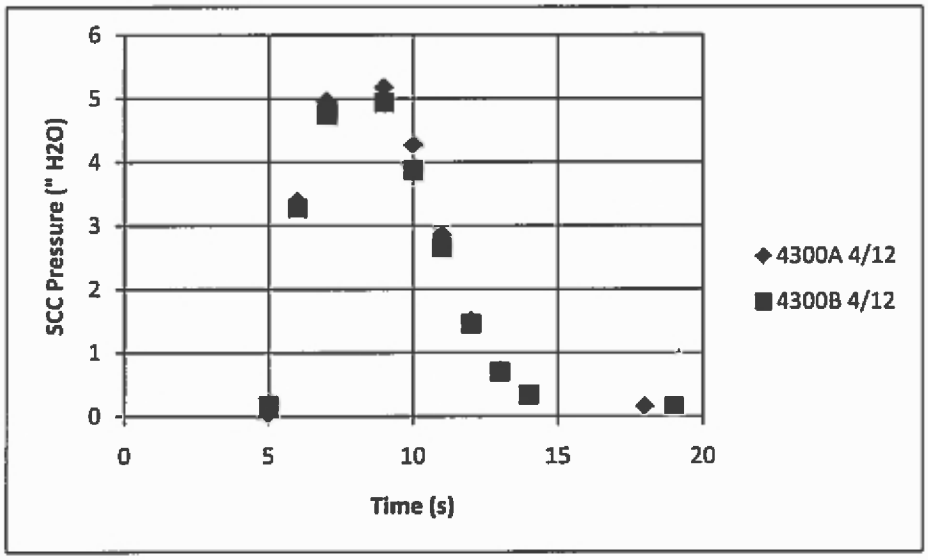

Figure 1. Transient SCC Pressure During 4/12/11 Event

2 EXPLOSION SCENARIOS CONSIDERED

Several hypothetical scenarios were evaluated to help determine the cause of this incident in light of the physical evidence and observations.

2.1 The Most Likely Scenario

Table 4. Sequence of Events for Most Likely Scenario

Time	Event	Supporting Evidence
7:45pm	Operators turn off cooling fan to the discharge end of the kiln. Brow begins weakening	Operator Statements
10:00 pm	Operators turn fans on again	Operator Statements
10:40:06	A portion of the brow drops into the slag pit followed by an accumulation of hot sand, causing an extremely rapid evaporation to steam.	A rumbling noise, several seconds long is heard for several seconds.
	The rapid evaporation throws metal objects from the pit and causes the liquid level to rise briefly. The liquid level drops as the water flashes to steam. An updraft of steam from the pit aspirates the kiln, causing the kiln pressure to decrease, and the air flow to increase.	The pressure record in the SCC shows a rapid increase in pressure. The Boiler pressures are always less than the SCC.
	The steam expands into the boiler, where it plastically deforms the walls and blows out the expansion joint leading to the spray drayer.	The ducting from the boiler is pushed into the spray dryer and the expansion joint is destroyed.

Table 5. Summary of Alternate Scenarios

No.	Scenario Description	Contradicting Physical Evidence
1	Drum BLEVE/explosion in kiln	Pressure in the Kiln drops from the normal operating pressure and temperature during the course of the event
2	Massive ash fall from SCC into slag pit	Consistent with data but the evaporation rate here is greater than witnessed previously
3	Vapor or dust explosion in SCC	SCC temperature never rises above normal and decreases with time. An SCC vapor/dust explosion would have caused it to rise. Pressure in the kiln drops from the normal during the course of the event.

4	Unburned hydrocarbon passed through SCC and deflagrated in boiler	No temperature increase in boiler or SCC. Boiler pressures always lower than SCC. SCC O2 concentration less than 12%.
5	A portion of the brow falls, allowing molten slag to fall out of kiln into slag pit	Consistent with data but rapid vaporization needed.
6	Slag buildup in SCC loosened by fluoride (scenario 2 with a cause)	Consistent with data – the evaporation rate here is greater than witnessed previously
7	Change in SCC performance due to lower operating temperature	
8	Combined scenario 2 and 4	No temperature increase in boiler or SCC. Boiler pressures always lower than SCC. SCC O2 concentration less than 12%.
9	Brow falls and vaporizes	Consistent with data – the evaporation rate here is greater than witnessed previously
10	Failure of combustion air	The primary air flow increases during the event (see Figure 3)

2.2 A VCE Propagating Through the System – Rejected

Three of these scenarios consider the possibility that a flammable vapor cloud propagated through the system as far as the boiler (Scenarios 4, 8, and 10) .

These scenarios were rejected because:

- The pressure downstream of the SCC should have been higher than the SCC at some point in time for this to have been true.
- All temperatures decreased during the event. A combustion event should have caused some of the, even momentarily, to rise.
- The SCC showed a drop in oxygen concentration below that needed for combustion. After several seconds, when the oxygen concentration later returned to a level that would have permitted combustion, pressure and temperature levels had all returned to normal levels. An explosion event after some initial event and period of gas flow through the system is not supported by the data.

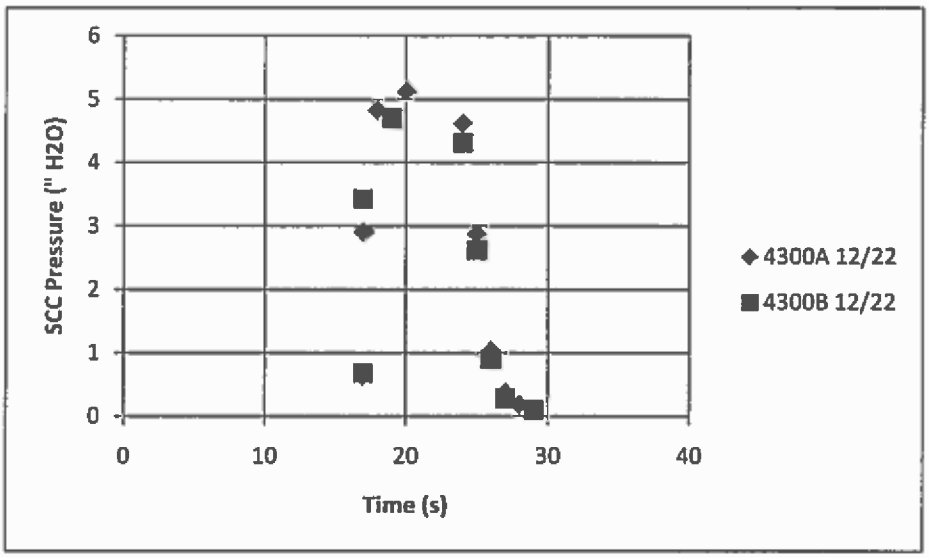

Figure 2. Transient SCC Pressure During 12/22/10 Event

4. The primary flow from the kiln increased sharply during the incident (FI 3410).

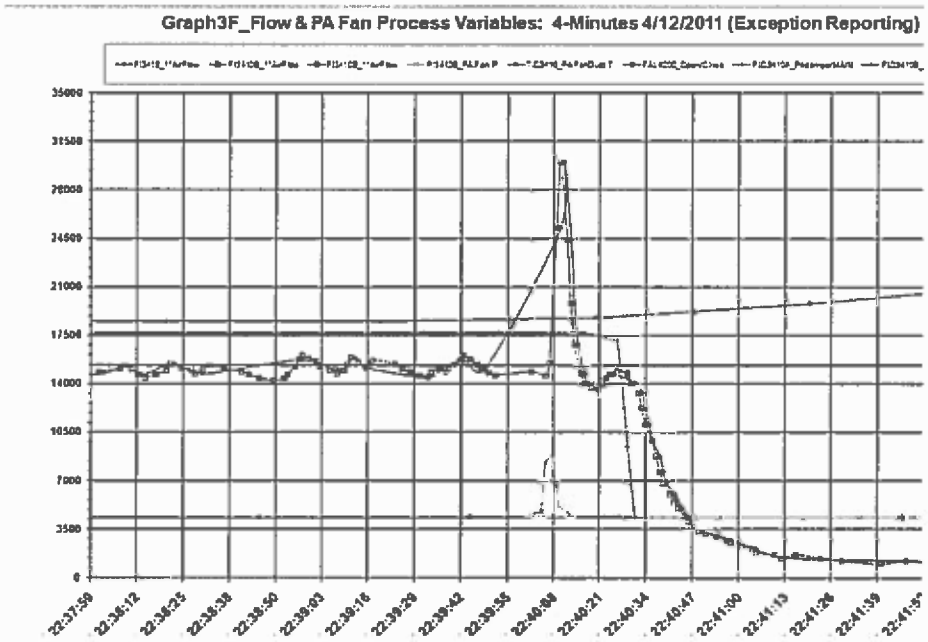

Figure 3. Primary Air Flow Response

5. The oxygen concentration dropped suddenly in the SCC (as shown in Figure 4), below the 12% needed for combustion.

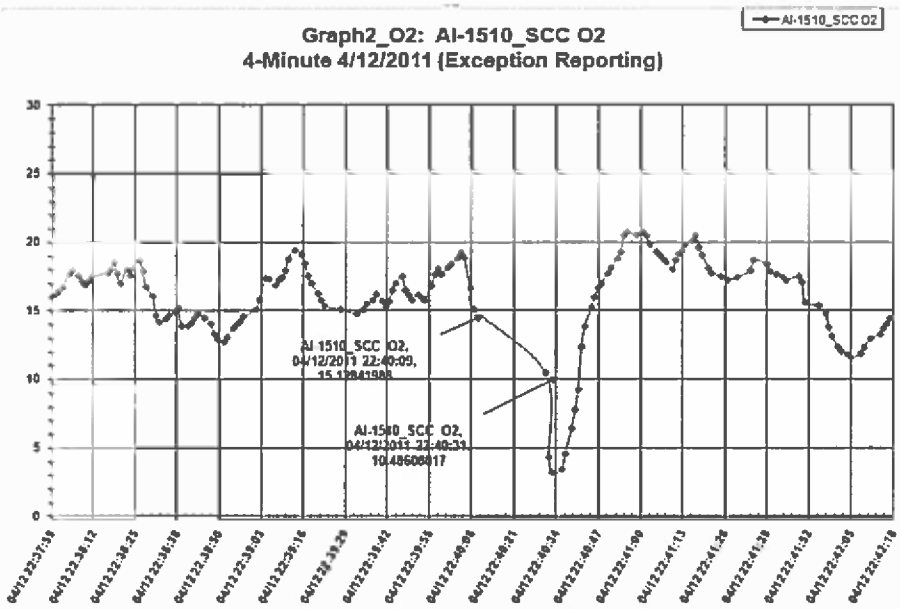

Figure 4. SCC Concentration as a Function of Time

6. The boiler received an internal pressure beyond its design capacity, as evidenced by the 7-inch plastic deformation in the walls.
7. The pressure in the system was great enough to fail the expansion joint between the boiler and the spray dryer.
8. The temperature in the kiln, SCC, and boiler decrease during the event as shown in Figure 5.

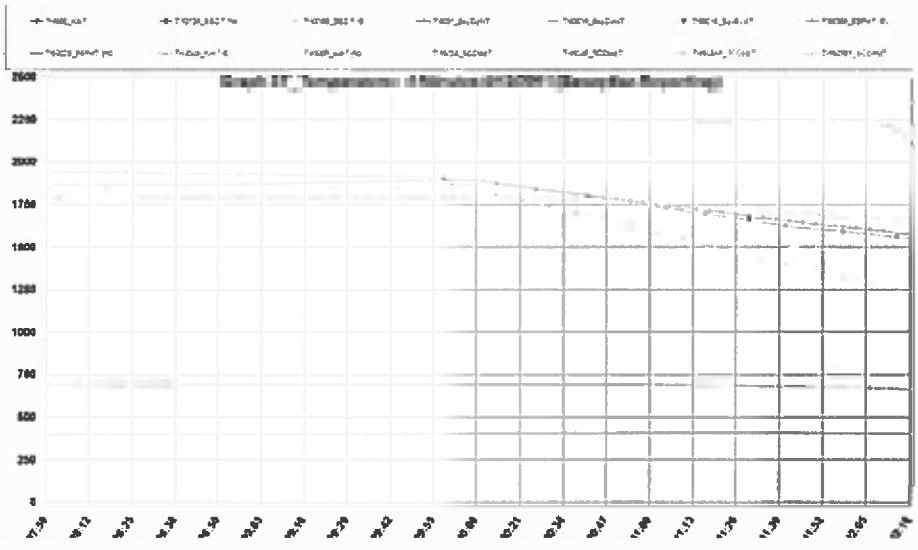

Figure 5. Temperature Response in the Kiln, SCC, and Boiler

9. The differential pressure from the Kiln to the SCC shows a pressure reversal (flow into the kiln) during the event

Table 2. Differential Pressure from the Kiln to the SCC

Time	PDT 4306
22:40:05	0.2
22:40:06	0.25
22:40:07	-4.0
22:40:08	-4.8
22:40:09	-4.9
22:40:10	-3.5
22:40:11	-2.0
22:40:12	-0.45

Should - SCC

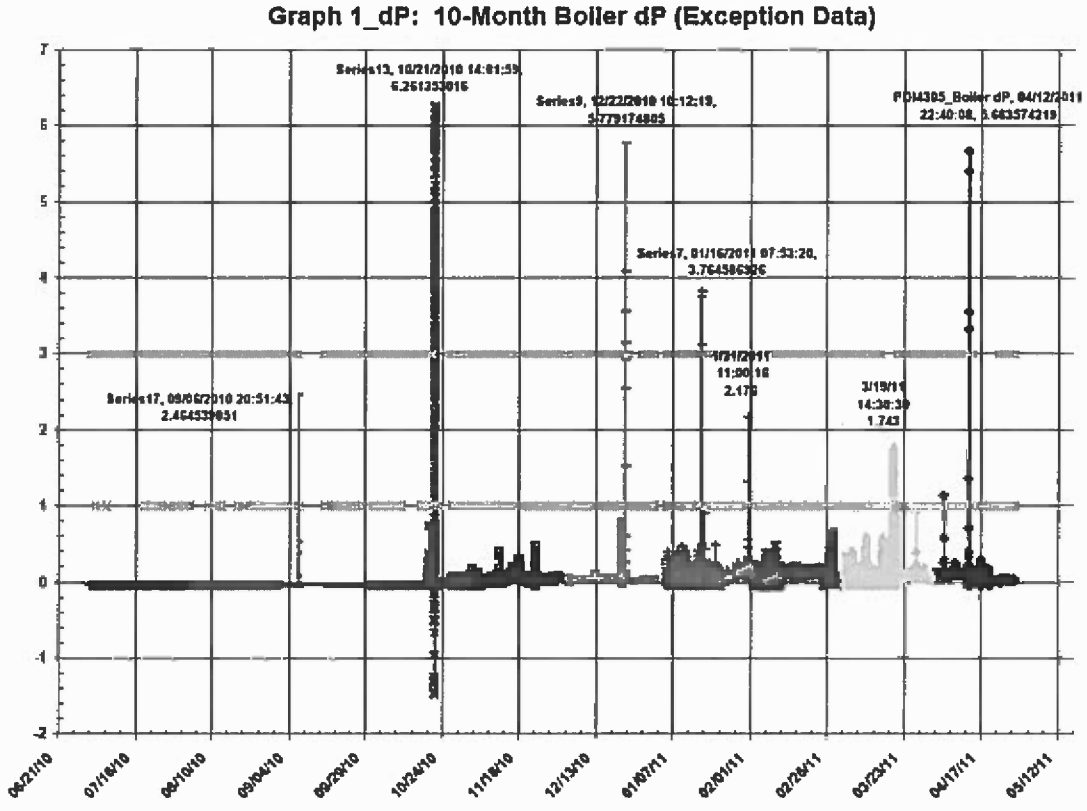

Figure 6. Exception Data for the Boiler DP

10. The liquid level in the quench pit rises suddenly then falls as shown in Figure 7. This behavior is quite similar to the records of the December 22, 2010 incident and the Jan 16, 2011 incident. A considerable amount of water is lost (vaporized). The liquid level in the pit drops more than 20 inches.

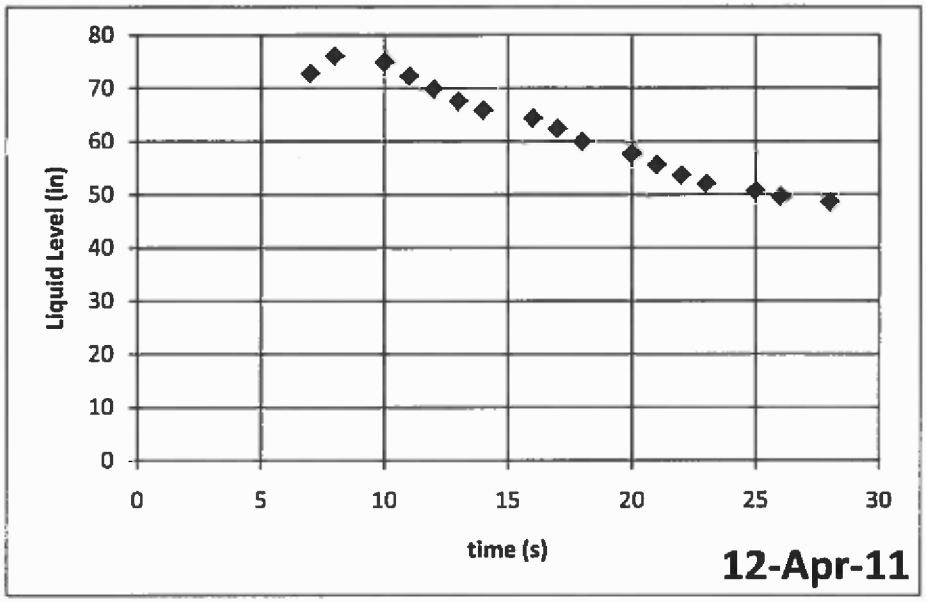

Figure 7. Liquid Level as a Function of Time (Time Zero =22:40:00)

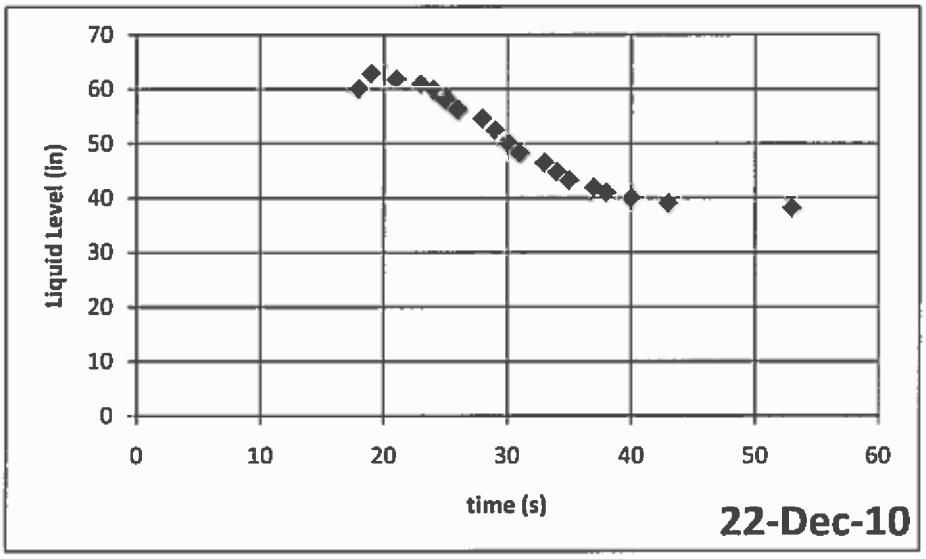

Figure 8. Liquid Level as a Function of Time for Dec 22, 2010 Incident

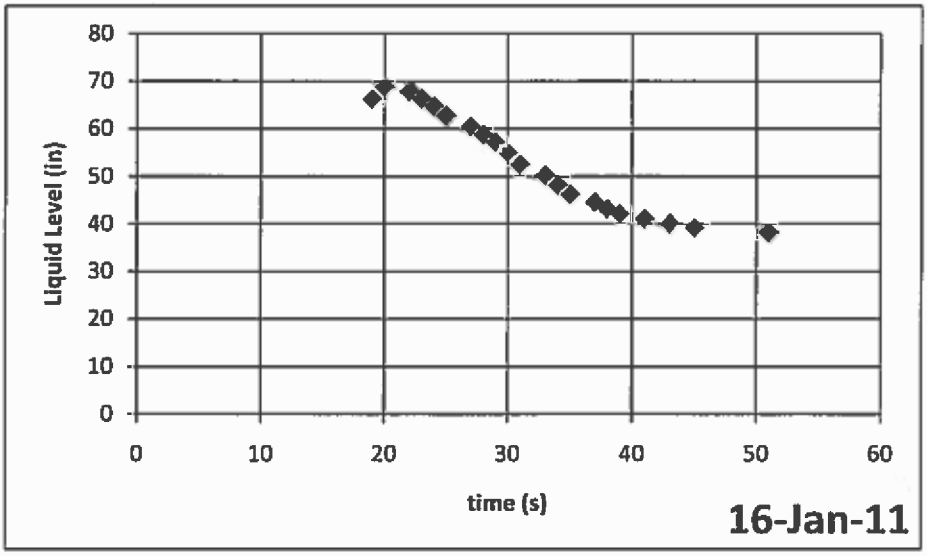

Figure 9. Liquid Level as a Function of Time for January 16, 2011 Incident

11. Drums were reported to have been thrown from the slag pit.
12. Smoke and ash was observed coming from the system, but not flame.
13. Camera trained on the end of the kiln shows it go dark.
14. The drums being processed at the time of the incident were filled with fine sand.
15. Some patches of ash missing from the upper north and southwest walls of the SCC.
16. Process changes since November 2010

Table 3. Process Changes Since November 2010

Condition	Before Nov 2010	After Nov 2010
Minimum T4300	1760 F	1718F
Minimum T43210	1795F	1747F
Max Process Flow Rate (FI 7510)	62857 SCFM	67505 SCFM